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Abstract

# FUEL CYCLE ECONOMICS OF URANIUM FUELED THERMAL REACTORS

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This paper discusses current and near-term technical and economic aspects of the fuel cycles of four classes of uranium fueled thermal reactors: Boiling Water (BWR), Heavy Water (HWR), Pressurized Water (PWR), and Sodium Graphite (SGR).

Thermal reactors using the thorium fuel cycle and plutonium recycle are discussed in other U.S. papers.

Actual performance data for complete irradiation cycles of the reactors under discussion herein are still somewhat limited in availability, although the performance that has been accrued is very encouraging. As of the end of 1963, three large prototype power reactors have been refueled in the U.S. One of these reactors is the Shippingport PWR which is not specifically discussed in this paper although it has provided a large amount of information on the performance of uranium fueled thermal reactors. The other two are the Dresden BWR and the Yankee PWR. In each of these cases, the fuel performance was generally as had been predicted. The fuel costs actually experienced to date are of course substantially greater than cost estimates for future fuel discharge batches.

The Hallam SGR and the Carolinas-Virginia HWR are small prototype plants, each of which is operating on its first core loading.

A number of analytical approaches can be followed in computing the fuel cost of a reactor once the fuel performance characteristics have been specified. In order to achieve a better understanding of the fuel costs discussed in this paper, a specific computation of fuel cost is set forth in detail. A method of computing "working capital" charges on the fuel cost is also presented. Depending on the overall cash flow as a function of fuel cycle

time, there can arise important differences in working capital requirements in support of fuel cycle operations for reactors which otherwise might have similar fuel costs. Private ownership of the nuclear fuel inventory is an especially important case requiring an accurate assessment of working capital requirement.

Reactors presently under construction (PWR's and BWR's) and reactors which can be constructed in the immediate future (HWR's and SGR's) have estimated fuel costs which are markedly lower than plants currently in operation. Estimates for near-term economic performance of the fuel cycle of each of the thermal reactors under discussion herein are presented and discussed.

Besides making technical progress in reactor fuel performance characteristics, improvement is being made in the unit charges of the various supporting operations for the fuel cycle. At the last Geneva Conference, the U.S. schedule of charges for enriched uranium could be found to correspond with a charge for natural uranium feed of $39.3 per Kg uranium as $UF_6$ and a charge for separative work of $37.3 per Kg uranium. Now, the U.S. schedule of charges for enriched uranium can be found to correspond with natural uranium feed at $23.5 per Kg uranium as $UF_6$ and separative work at $30 per Kg uranium. This change alone has reduced thermal reactor fuel costs by some 0.5 mil/KWH.

The change in fuel cost arising from changes in selected parameters, both of a technical and economic nature, is discussed and quantitative data for selected cases are presented.